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INQUIRY *into the* CONSISTENCY *of* Dr. HUTTON'S THEORY
of the EARTH *with the* ARRANGEMENT *of the* STRATA, *and*
other PHÆNOMENA *on the* BASALTIC *Coast of* Antrim. *By the*
 Rev. WILLIAM RICHARDSON, D. D.

Read May 2d, 1803.

Quod necum ignorat solus vult scire videri.

PHILOSOPHERS at all times seem to have been seized with a sort of rage for inventing and supporting theories, and for explaining the operations of nature, and the phænomena she exhibits, upon principles discovered by themselves; they seem to have considered it as humiliating to admit they were not privy to her secrets, and that they were unable to explain the manner in which her various works were executed.

The mere adoption of the opinions of others could not procure celebrity; hence it became necessary, that those who thirsted for fame, should strike out something new, which, while it shewed their own sagacity, gave them an opportunity also of displaying their ability in support of the systems they invented.

Thus the attention of mankind was diverted from the study of nature to the discussion of opinions; for even those who did not invent, thought it necessary to adopt some theory, for which they
 soon

soon acquired a strong partiality, and became zealous to procure profelytes to it.

Hence the progress of natural history was small, and our knowledge doubtful; the causes of which did not escape the sagacious *Bacon*, who says, “the principal reason of uncertainty seems to be, that every enquirer carries his own *Idol*, or some preconceived notion along with him, to which he wrests all the facts, and the phænomena.”

Had this great philosopher lived in our day, he could not have better described the feelings of the naturalists who have visited, and published accounts of the basaltic coast of Ireland; every one of them avows his favourite theory, and twists trifling facts to support it, letting the great features of nature, and the arrangement of her materials escape him, when a very slight attention to these would instantly have shewn him the insufficiency of his own theory.

Encouraged by the authority of Chancellor *Bacon*, I will venture to discuss some of the theories, which of late have become so fashionable, and try them by the test of *facts*, an ordeal which few of them can stand.

Lord *Bacon* says, “We cannot, perhaps, deserve better of mankind, than by endeavouring to free them from the tyranny of *false doctrines*, and *theories*, and bring them by a kind of *learned experience* to a more close and exact acquaintance with things themselves.”—Lord *Bacon* thus expressed his disapprobation of theories, merely because they impeded the progress of science, and especially of natural history; he did not foresee that, at a future period, in the hands of *Antichristian Conspirators*, they would be made instruments to support infidelity, concealed under the mask of mere physical opinions, whose object was (as the ingenious Abbè Barruel clearly proves) to shew, “That a much longer space of time is required for the formation of the universe, than the history of the creation, as delineated by *Moses*, leaves us room to suppose.”

That

That Dr. *Hutton*, in inventing the theory called by his name, had any such object in view, I by no means insinuate. It would be unfair to impute to any man motives he does not avow, and illiberal to attack a gentleman, who, having paid the debt of nature, can no longer defend himself. And after all, the question is purely physical; for, whatever Dr. *Hutton's* motives may have been, if his theory be established, we cannot prevent other men's deducing from the proposition such corollaries as it will fairly bear; and if it be overturned, all remoter inferences fall with it.

When I avow my intentions of attacking this fashionable theory, it will naturally be asked,

Cur tamen hoc libeat potius decurrere campo,
Per quem magnus equos Auruncæ flexit alumnus?

Why I select a topic, upon which the celebrated Mr. *Kirwan* has displayed his ability?—It would be a poor justification of myself to alledge, that after the most ingenious advocates, something still may remain to be said; I make no such plea; a Department is left for me. Dr. *Hutton*, armed at all points, not content with establishing his theory most diffusively, *a priori*, admits that if it be true, it ought to be confirmed by certain *facts*, and then proceeds to assert that the *facts* are found exactly as he foretold; thus claiming to have proved his theory also *a posteriori*.

Now, as I have spent very many summers, and still occasionally reside upon a coast lined to a great extent by perpendicular precipices, often of enormous height, I have had better opportunities than most people, of examining the order in which nature has arranged her materials, that is, the strata of which the superficial part of our globe is composed; and as Dr. *Hutton* seems to rely for the support of his theory chiefly upon the positions of these strata, and other circumstances attending them, I have often compared his assertions with the *facts*, in many places magnificently displayed before me.

I will

I will venture to assign also another reason. Abbè *Barruel* has proved, “That one of the resources of the Antichristian Conspirators was to inffinuate error and infidelity into those articles, that might be deemed least fufceptible of them, fuch as hiftory and natural philofophy.” It therefore becomes neceffary for thofe, who revere the opinions in which they were educated, to watch thefe new fyftems as they appear, and enquire into their remote tendency, though unavowed by the author. A reference to the real ftate of things (the *Book of Nature*, as Dr. *Hutton* expreffes himfelf,) feldom fails to detect the futility of fuch whimsies, and I hope will alfo overturn his own theory, whatever may have been his motive for diffeminating it.

The efficacy of this mode of proceeding in a cafe to which I take the liberty of digreffing, will, I hope, juftify me in advifing thofe, who admit the neceffity of repelling thefe frequent attacks upon revelation, firft, *carefully to afcertain the facts*, before they fuffer themfelves to be led into the mazes of *theory*, and puzzled by fpeculations *a priori*.

A popular and lively traveller, Mr. *Brydone*, ftates, that it has been difcovered in *Sicily*, that the world is of a much older date than has generally been fupposed; that, by finking wells, fucceffive strata of lava have been found (at *Iaci* not lefs than feven) with layers of vegetable earth between them. Now, as thefe lavas muft have been produced by fucceffive eruptions, if the time can be eftimated, which is required for a current of glowing lava to acquire a covering of vegetable earth, and that time be multiplied by fix (the number of layers of earth) we have the period of the firft eruption, which is thus thrown back to a diftance utterly incompatible with the chronology of *Mofes*.

Though this argument has been often refuted, yet, as it is ftill urged with much triumph, I will venture to encounter it upon new ground.

From

From an attentive consideration of Mr. *Dolomieu's* catalogue of the volcanic productions of Etna, (republished by Mr. *St. Fond*) and the accurate and minute account it gives of the strata of the country (currents of lava Mr. *Dolomieu* generally calls them) I have long been induced to think, that Sicily, in its original construction, strongly resembled the basaltic part of my own country, being, like it, composed of basalt strata, often prismatic and columnar, sometimes alternating with calcareous strata, and with others composed of marine depositions and exuviae; that in this state Etna erupted, and frequently covered with its lavas and scoria the preexisting basaltic and marine strata.

Conversing once on this subject with my friend, *Professor Pictet* of Geneva, he requested me to put my sentiments on paper, that he might communicate them to his friend Mr. *Dolomieu*: I did so, and aware that I was exposing myself to a charge of presumption, for discussing the construction and productions of a country I had never seen, I limited myself rigidly to the facts stated, and admissions made by Mr. *Dolomieu* himself; but, before my observations could reach him, he was no more. *Professor Pictet* has since published them, in his *Bibliothèque Britannique*, No. 144.

My conjecture, that many of the strata of Sicily, though called by Mr. *Dolomieu* currents of lava, were not actually such, has since been confirmed by observations made on the spot by Sir *James Hall*, Bart. a skilful naturalist, and able chemist, who first discovered the mode of fusing basalt without vitrifying it, therefore little likely to be mistaken upon a basaltic subject.

Sir James tells us in the transactions of the Royal Society of Edinburgh “for the year 1799, “It is generally supposed, that some lavas of Etna contain calcareous spar and zeolite; but, this I conceive to be a mistake. It is “true, as I have seen, that many rocks of Etna contain these substances in abundance; but, in my opinion, these rocks are no lavas, but have flowed subterraneously like our whins, and are the

“same with them in every respect. A particular district of Etna, comprehending the Cyclopiian Islands, the country round La Frezza, and the castle of Jaci, is decidedly of this description.” *

Here we have the most respectable authority for saying, what Mr. *Brydone* flippantly calls *currents of lava*, never flowed from any volcano; of course, all his calculations vanish in air.

Previous to entering into any discussion of Dr. *Hutton's* system, ludicrously, yet properly enough styled *The Plutonic Theory*, I will give a short epitome of it, that such readers as are not already acquainted with it, may be aware how much it is expected they shall believe.

Dr. *Hutton* asserts, that the materials of which the surface of this world is composed, loose and solid, are perpetually decaying, or decomposing, and in that state are washed away by the rivers into the sea, thence by the tides and currents into the unfathomable regions of the ocean:

That our surface, thus perpetually diminishing, in length of time is completely carried off, and deposited in the form of horizontal strata at the bottom of the sea:

That *there* fires are by some mysterious operation kindled, by which the loose materials of these strata are fused and consolidated into the hardest rocks, as *marble*, and every other species of stone, except *granite*, of which the Doctor has some doubt:†

That

* These were the places, together with Paterno and La Mothe, which I selected as the subject of my observations intended for the late Mr. *Dolomieu*.

† Dr. *Beddoes* gets over Dr. *Hutton's* difficulties (whatever they were) by asserting basalt (with him unquestionable lava) and *granite* to pass into each other; an assertion I should not have minded, had he not drawn his *proof* from my country, considering the *why* stone of the Fairhead pillars as an approximation to granite.

Our country affords many varieties of basalt, that of Fairhead is somewhat more granular and of a lighter colour than the fine blue Giant's Causeway basalt, but it is obviously pure basalt; nor did I ever there, or any where with us, observe the trace of a passage of basalt into granite. In truth we have very little granite, and what I have met with was invariably of the red species.

That in proper time these fires assume a new office, and in a sudden paroxysm of expansion burst and break these strata, with every species of *dislocation and contorsion*, raising them up to the greatest heights, so that of what was just now at the bottom of the sea we may pronounce, with *Manilius*,

Altius his nihil est, hæc sunt fastigia mundi :-

These are the mountains of a new world ready for occupation, which in like manner is to steal away to the *unfathomable regions of the ocean*, to undergo the same operations that have been performed on its predecessor.

At first view of this theory of Dr. *Hutton's*, the reader will probably say, that the friends of old opinions need not be under any alarm, lest the authority upon which their opinions are founded, should be invalidated by this or similar systems; that their advocates will find sufficient employment in establishing their own doctrines; and that such a rotation of destruction and renovation, as Dr. *Hutton* assumes, will of itself find difficulty enough in obtaining credit.

Yet it appears, that most of the naturalists of a neighbouring nation, whose zeal for the advancement of every species of literature deserves the highest applause, have adopted Dr. *Hutton's* theory; that they support it with their pens and from their chairs; and (like Sir *James Hall*, just quoted) catch at incidental opportunities to express their approbation of it.

An opinion so respectably maintained and defended should not be hastily prejudged from the wildness it may exhibit at first view. Dr. *Hutton* seems to have possessed in a high degree the esteem of his contemporaries. This flattering testimony must secure to his opinions the most respectful attention, even from those who do not accede to them, but who will, I hope, be excused for enquiring into his pre-

tensions, before they allow the partiality of his countrymen to place him in a rank with *Newton* or *Copernicus*.

Dr. *Hutton's* friend and pangyrift, *Professor Playfair*, among other eulogiums he bestows upon his late master's theory, says, (page 127) "It is impossible not to be struck with the novelty and beauty of the views which it sets before us, and which point it out as a work of great and original invention;" And again, (page 134) "Dr. *Hutton's* theory merits, in the strictest sense, the appellation of *new* and original."

But whatever other merit Dr. *Hutton's* system may have, it cannot claim that of novelty; for it seems strongly to resemble the opinions entertained by *Heraclitus* of old, and which he assigns as the cause of his melancholy.*

Among the moderns who may contend with Dr. *Hutton* for the credit of this invention, the most formidable will probably be found among the sect of the *Illuminati*, who have their opinions accurately laid down and detailed in the lecture of a Prussian Illuminè, a knight of the *Phoenix*, who gives us a sort of a physical creed, which those who wished to become members of the society must previously adopt. I will quote a passage from this lecture, as published by the *Abbè Barruel*.

"After

*——τὰ μὲν παρόντα οὐ δοκέω μεγάλα, τὰ δ' ὑτέρῃ χρόνῳ ἐσόμενα πάμπαν ἀνηρά· λέγω δὲ τὰς ἐκπυρώσεις, καὶ τὴν τῶ ὅλου συμφορὴν. Ταῦτ' ὀδύρομαι, καὶ ὅτι ἔμπεδον ἔδεν, ἀλλὰ καὶ εἰς κινεῶνα πάντα συνελίσσεται—μέγα, μικρόν· ἅνω κάτω περιχρόζοντα, καὶ ἀμείδόμενα ἐν τῇ τοῦ αἰῶνος παιδιῇ. LUCIAN. Βίων Πρασις. Chap. 10.

He says, "The present state of things I do not much admire, and what is to happen in future I consider as quite calamitous; for I expect conflagrations and the subversion of the universe. Therefore I weep; because I see nothing stable and fixed; and all things are to be mixed up in a sort of hodge-podge, great and small, whisked about, up and down, inverted in the sport of time."

“After his first lesson, our Illuminè proceeded to explain his other symbols. This serpent, forming a circle, (says he) is the emblem of the eternity of the world; which, like this serpent, has neither beginning nor end. The serpent, you may also know, has the property of annually renovating its skin. This will figure to you the revolutions of the universe and of nature, which appears to weaken and even to perish at certain epochs, but which, in the immensity of ages, only grows old to become young again, and to prepare for new revolutions.—This phenix, is a still more natural exposition of the succession and perpetuation of these phenomena. Mythology has represented this bird as revivifying from its own ashes, only to shew how the universe is reproduced, and will continue to be so from itself.”

As I have no other materials but Dr. *Hutton's* memoir, from which I can form a conjecture as to his opinions, I would be sorry rashly to ascribe to him any of the principles of this dangerous sect: on one point, indeed, their language is very similar, the *Knight of the Phenix*, says, *the world, like this serpent, has neither beginning nor end*; and Dr. *Hutton* concludes his elaborate dissertation with these words: “*The result, therefore, of our present enquiry is, that we find no vestige of a beginning, no prospect of an end.*” (Edinb. Transact. Vol. 1st. page 304.)

Mr. *Playfair* cannot bear to have these two positions confounded; the former he condemns harshly, (page 120) but highly applauds the latter.

The distinction between the position, “*the world has neither beginning nor end,*” and the assertion, “*we find no vestige of a beginning, no prospect of an end,*” may be ingenious, but it is not new; *Pere Arnauld* was censured by the Sorbonne, not for denying that certain propositions condemned by the Pope were to be found in *Jansenius's* book, but for saying, “*that having read the book carefully, he could not find them;*” and he is just as ready to condemn them wherever they

they are found, as Mr. *Playfair* is to pronounce the position, the world has neither beginning nor end, to be *presumptuous* and *unwarrantable*. What credit Mr. *Playfair* will obtain for his distinctions, remains to be determined. *Pere Arnould's* availed him nothing; the jesuits of the *Sorbonne* understood distinctions perfectly well, but not liking to have them made use of against themselves, they found *Pere Arnould* guilty. (Lettres Prov.)

Mr. *Playfair* is very irritable on the subject of these distinctions; and treats Mr. *Kirwan* with great asperity, because he did not seem to comprehend them; and also because he presumed to *censure the tendency of Dr. Hutton's opinions*.

The intention of an author, and the *tendency* of his opinions, are distinct questions; the former may be innocent, the latter pernicious: of his intentions we should not rashly pronounce, as we cannot be sure we are right; but the tendency of his *published* opinions is a question of which the public is in possession, and any attempt to deter from an inquiry into this tendency is an infringement of the liberty of discussion. Instead of scolding, Mr. *Playfair* should have shewn, that this position of his friend had not any tendency that deserved censure, for this is the point at issue.

An impeachment of the credibility of *Moses* has of late, it appears, been a favourite topic; and the mode of attack most frequently adopted is, by contradicting his chronology in the date of the creation.

Every reader will probably form a conjecture as to Dr. *Hutton's* intentions, when he reads his assertion, *that he could find no traces of a beginning of the world*; and, as to the *tendency* of such positions, I shall rest it upon the authority of a personage more knowing in these matters than Mr. *Kirwan* or Mr. *Playfair*, I mean Mr. *D'Alembert*, who spent his life in disseminating opinions merely for the sake of
their

their tendency, and encouraged physical pursuits for the sole purpose of extracting conclusions contradicting the chronology of *Moses*.

Yet Mr. *D'Alembert* is just as much hurt as Mr. *Playfair* himself, when the intentions of his friends, and the tendency of their works are deemed hostile to revelation; and bestirs himself with equal zeal to clear them of the imputation.

"Divines," (says he) have sought to connect Christianity with systems purely philosophical; in vain did religion, so simple in its tenets, constantly throw off the alloy that disfigured it; it is from that alloy that the notion has arisen, of its being attacked in works, where nothing was farther from the minds of the writers." (*Abuse of Criticism*.)

Such is the language Mr. *D'Alembert* holds out to the public; he talks in a very different style to *Voltaire*, his friend and ally in his attacks upon revelation, to whom he writes thus:

"This letter, my dear companion, will be delivered to you by *Desmarets*, a man of merit and of sound philosophy, who wishes to pay his respects to you, on his journey to *Italy*, where he purposes making such observations on natural history, as may very well give the lie to *Moses*; he will not say a word of this to the master of the sacred palace; but if, perchance, he should discover that the world is more ancient than even the Septuagint pretend, he will not keep it a secret from you." (Vol. 68, Letter 137.)

This unprejudiced naturalist, who has determined upon his conclusion, before he examines the facts, that is, the premises from which he is to deduce it; this associate of *Voltaire* and *D'Alembert*, in their labours to rid mankind of their religious prejudices, this same *M. Desmarets* is now stiled the father of the volcanic theory, having, in the course of the mission upon which we have traced him, discovered basalt to be a volcanic production: nor did he neglect to apply his discovery to the main object of his mission, to wit, an impeachment of the credibility of *Moses*, for it appears, he industriously disseminated his doctrines

trines upon his route, where Mr. *Brydone* picks them up as he followed him, two or three years afterwards, and retails them *con amore*.

I have often wondered how this theory, irreconcilable to common sense, unsupported by any evidence, and contradicted by a thousand stubborn facts, came to make its way so generally in the world.

M. *D'Alembert's* letter to *Voltaire* clears up the difficulty; these gentlemen and their associates had then got possession of the French academy; they alone had the public ear, they extolled the writings, and supposed discoveries of their partisans, and as they were mostly men eminent for their literary merit, and not then suspected of any sinister intentions, they necessarily gave the ton, and the theories and discoveries which they approved (with apparent impartiality) were upon their credit implicitly received by the world.

Thus the volcanic origin of basalt is admitted as a proposition already demonstrated, and perpetually quoted as such, without further enquiry.

I am happy to find, that on this point (the volcanic origin of basalt) I agree in opinion with Dr. *Hutton*, and his friends, and I hope this coincidence will procure my excuse for making some further observations on his position, that *he could find no vestige of a beginning, no prospect of an end*.

This epitome of Dr. *Hutton's* discoveries, the result of so much laborious investigation, has still less claim to novelty than his theory itself; there seems to be something fascinating in the atheistical proposition, *the world has neither beginning nor end*, since at all times, so much pains have been taken to extract it as a conclusion from different premises; nor is Dr. *Hutton* the only person that gravely announces the important discovery as if made by himself.

I will take the liberty of quoting the *Vicar of Wakefield's* friend, Mr. *Jenkinson's*, account of this question. "Aye, sir, replied he," as if he had reserved all his learning to that moment, "Aye, sir, the
" world is in its dotage, and yet the cosmogony or creation of the
" world has puzzled philosophers of all ages; what a medly of opi-
" nions

“ nions have been broached upon the creation of the world ; Sancho-
 “ niathon, Berofus, Manetho, and Ocellus Lucanus, have all attempted
 “ it in vain ; the latter has thefe words ; *anarchon ara kai atcleutaion*
 “ *to pan* ; which imply, that all things have neither beginning nor end.”

As thefe gentlemen exprefs their opinion very nearly in the fame words, they feem alfo to agree in another point, to wit, that the difcovery of this great truth fecures to them the reputation of deep learning ; this laft circumftance probably induced them to overlook the evil confequences that might refult to fociety, from the removal of all religious obligation ; for it will fcarcely be denied, that the belief of the exiftence of a God has a ftrong influence upon the morals of mankind. *Ovid*, who knew the world very well, but did not pretend to any religion, wifhed to preferve this fundamental part of it (the belief of the exiftence of God,) for the fake of its influence ; he fays,

Expedit effe deos, et ut expedit, effe putemus.

And *Juvenal* ftates with precision, the bad effects of atheifm, in his day.

Sunt qui fortunæ in cafibus omnia ponunt,
 Et nullo credunt mundum rectore moveri,
 Atque ideo intrepide quæcunque altaria tangunt.

If this was a proper place, to difcufs the queftion of the exiftence of a God, and to prove, that the world was formed, not by chance, but by confummate wifdom, I would chearfully refer the decifion of thefe points to the fame authority which *Dr. Hutton* himfelf fo often quotes, *the book of nature*, a code which, I apprehend, will not be found very favourable to atheiftical opinions. But I find I am wandering from my fubject, and muft return to the actual merits of *Dr. Hutton's* theory of the earth, without inquiring farther who was its original inventor, or what motive he had for diffeminating it, and the conclufions he afferts refult from it.

Dr. *Hutton* reduces his argument very methodically, into three distinct Propositions, a division into which the subject obviously resolves itself :

1st. That the materials of this World are in constant motion, from its higher parts to the unfathomable regions of the Ocean, where they are deposited in Strata, horizontal or nearly so.*

2d. That the Strata composed of these loose materials, are there consolidated by subaqueous heat and fusion.

3d. That being so consolidated, they are afterwards elevated by the expansive force of heat, to the highest points of the earth, and in the operation are broken, dislocated, and distorted.

I must in general observe, before I proceed to examine the truth of Dr. *Hutton's* Theory, that it is necessary to be very watchful of his positions, which he slips in almost incidentally, and then proceeds to argue from them as if admitted. Thus, page 285 he says, “ Philosophers observing an apparent disorder and confusion in the solid parts of the Globe, have been led to conclude, that there formerly existed a more regular and uniform state—that there had happened some destructive change—that the original structure of the Earth had been broken and disturbed by some violent operation.”

Taking

* It is amusing to observe the wild and contradictory opinions, gravely maintained by Cosmogonists; Dr. *Hutton*, it appears, supposes the materials of the world to be in perpetual motion, from the land to the bottom of the sea; whereas, *M. La Trobe* gives them quite a contrary direction; he says,

“ Some Geogonists make fire, and others water, the principal agent in the formation of the globe, or at least of its present surface; but he (*M. La Trobe*) contends, that another element, *the wind*, has, in certain districts, no inconsiderable share in the operation. The daily action of the flood-tide conveys a certain quantity of fine sand above high-water mark, and this being dried by the sun and air, is carried farther inland by the winds.” [Trans. American Phil. Society, Vol. 4.]

The reader may smile; but both Dr. *Hutton* and *M. La Trobe*, are perfectly serious.

Taking all this at once for granted, Dr. Hutton says, " All these appearances find the most perfect explanation in the Theory he endeavours to establish, *and are the facts from which he reasons.*"

I can by no means admit the truth of these positions, which serve to justify the necessity of his theory, and actually (as he tells us) furnish his *Proofs*. The country which I have examined with care, has, (as will appear) suffered no *destructive change*; its materials and their arrangement, vary often, it is true, but the steady position of the strata of which it is composed, all horizontal or nearly so, shew, that *they have not been broken or disturbed by any violent operation.*

As the materials of this world, which, by Dr. Hutton's 1st proposition, *are in constant motion from its higher parts*, can be carried off from its surface alone, it becomes necessary to take a general view of the surface, and to examine of what materials it is composed.

I need not on this occasion take notice of our boundless ocean, nor the extensive plains covered with moveable sands, as they do not enter into this discussion.

The remainder of our surface is covered with a thin stratum of soil, well clothed with vegetables; through this naked rocks often appear; but these taken all together, bear a very small proportion to the parts adorned by verdure, and affording sustenance to numberless animals.

I consider this stratum of soil, with its vegetable coat, as a suit of armour, with which nature, in her wisdom, clothes the world, to protect its loose, moveable materials, and to prevent their being carried off by the rain and winds. The propensity of nature so to cover herself, is irresistible. Currents of Lava, in time, acquire a soil and vegetable cloathing. The bleakest parts of our wild rocks and mountains, are covered with their own soil, and their own vegetables; even the tops of the Giant's Causeway Pillars, where beyond the breach of the sea, are clothed with a fibrous, mossy earth, producing a good verdure.

Every one must have seen heaps of brick, when left long undisturbed, (the object for which they were burned being abandoned) gradually cover themselves with grass, and change apparently into green mounts.—I saw the same happen to a cargo of coals, in the garden of my late friend, *Hodgson Gage*, whose death prevented their being touched for many years. I do not know more perishable materials than each of these. The reader is to determine whether, according to *Dr. Hutton's* opinion, they would have found their way to the *unfathomable regions of the ocean*, or by the superinduced covering, were arrested on the spot for ever.

It has been deemed extraordinary, that the sites of *Babylon*, and other great cities of antiquity, cannot now be determined. This arises from the irresistible propensity of nature, to clothe herself with soil, and verdure; for, as soon as the perpendicular buildings collapse into ruins, a soil and grass covers them, and then,

—Priami Paridisque busto
Insultat armentum.—

It is this vegetable soil (which is, as it were, the advanced guard) that alone sustains the attacks of the numerous enemies, which, according to both *Dr. Hutton* and *Mr. Playfair*, combine their efforts to carry off our world to the unfathomable regions of the ocean.—All depredations committed upon our surface, are at the expence of this soil; its abrasions discolour our rivers in a flood, and are the source of all our muddy depositions; the original earth is rarely encroached upon, except in a few gullies and ravines of little consequence.

Fortunately this protecting coat is as easily replaced, as it is taken away, or in *Mr. Playfair's* words, *is augmented from other causes just as much as it is diminished.*

We

We will inquire into the materials from which this superficial covering is formed and repaired, when we have taken a slight view of our naked rocks, to discover if they be really mouldering away, as these gentlemen suppose.

Mr. *Kirwan* considers the rocks on the sea-shore, exposed to the breach of the sea, and almost constantly wet, as not suffering the slightest diminution. I have examined many parts of our rocky coast with an eye to this question, and am clear that Mr. *Kirwan* is right: I find no difference between the spots where the sea breaks with the greatest violence, and those which by some local protection are left tranquil; not the least appearance of wearing away is to be observed at either of them.

The degradation of the dry inland rocks is more questionable; their surface is often well protected by a covering of *Lichen* and *Byffus Saxatilis*. The Trappe, I find, on our high grounds and mountains, are for half an inch within the surface, somewhat less found, and vary a little in colour from the interior of the stone; but I do not find, nor believe, that they decompose further, so as to crumble down; but if they do, the materials only fall to the foot of the rock, where (at least in our moist climate) they are soon covered with verdure, and arrested for ever.

Mr. *Playfair* speaks very positively on this subject. He says, "The atmosphere is the region where stones are decomposed, and again resolved into earth. This decomposition of all mineral substances exposed to the air, is continual." [Illus. page 97.]

"The law of decay is one that suffers no exception." [Page 116.]

I can by no means accede to these positions to the extent Mr. *Playfair* would carry them; the calcareous rocks, it is true, that bound the valley of the Nile, are, as we are told by *Denon*, perpetually decomposing; but, on our northern shore of *Antrim*, the atmosphere does not appear to make the least impression on our immense facades of white limestone; and in *Egypt*, the granite has withstood decomposition above 4000 years. "The marks (says *Denon*) of these first operations, are preserved

“ served so fresh in this unalterable material, that to look at them,
 “ one would suspect that the work had been suspended only yesterday.”
 [Travels, chap. 17.]

The decomposition of Basalt rocks, seems more questionable. I know that both the plain sides of prisms, newly exposed to the air, and also all recent fractures, very soon acquire a sort of rust, well accounted for by Mr. *Playfair*, who says, “ by the action of air and moisture, the iron “ becomes oxydated in such a degree, as to lose its tenacity, so that “ the texture of the surface is destroyed.” I strongly suspect this decomposition has its limit, and that this rust forms a sort of paste on the surface of the stone, which protects it from farther injury. I never saw a basalt pillar, which had the appearance of having suffered any diminution, farther than a slight blunting of its angles; the articulations too, suffer a little, and the points or pyramids which ascend from the lower joint often fall down, but all pillars of the most ancient exposure, seem to preserve their original diameters.

The more general account of the state of our world, as given by both Dr. *Hutton* and Mr. *Playfair*, is very alarming. The latter asserts, that, “ a system of universal degradation, and decay, may be traced over “ the whole surface of the land, from the mountain top to the sea- “ shore”; and, “ that water from the smallest rill to the greatest river “ attacks whatever has emerged above the level of the sea, and la- “ bours incessantly to restore it to the deep.” (page 99, 100.)

Mr. *Playfair* supposes a geologist suddenly transported “ into alpine “ tracts, where the surface of the earth attains its greatest elevation,” and then details the train of his reflections.

The first impression on his mind is made *by the novelty and magnificence of the spectacle before him*; he then finds out the caducity of the objects around him, and like another *Xerxes*, looking down with a melancholy eye upon his innumerable host, and weeping when he reflects on the short period of existence they have to enjoy, Mr. *Playfair*'s geologist “ begins to discover the footsteps of time, and to perceive,

“ceive that the works of nature, usually deemed the most permanent, are those on which the characters of vicissitude are most deeply imprinted; he sees himself in the midst of a vast ruin, where the precipices which rise on all sides with such boldness and asperity, do but mark so many epochs in the progress of decay.” (Illustrations page 110.)

Dr. *Hutton* is full as gloomy; he says, (page 296) “in the natural operations of the world, the land is perishing continually; and on the mountain top nothing is to be observed but continual decay.”

And in another place, “if the vegetable soil is thus constantly removed from the surface of the land, and if its place be supplied from the dissolution of the solid earth, we may perceive an end to this beautiful machine:” and again, “we are therefore to consider as inevitable, the destruction of our land.” (Edin. Transf. page 115.)

Notwithstanding this desponding picture, I hope to prove, that the softer parts of our earth are still less in danger of dissolution, than our most solid rocks. I must dwell a little on these topics, for two reasons.

First, because I have met with intelligent persons who could not reconcile themselves to Dr. *Hutton*’s subaqueous fusions, or to his elevations of strata by igneous expansions; yet agreed with him in opinion, that the superficial parts of the world were gradually wearing away.

Secondly, because it is a question not of theory and speculation, but one upon which every intelligent person is qualified to form an adequate judgment from his own observation.

The proof of Dr. *Hutton*’s first proposition (the present question) turns much upon the definition of a soil, which, with Mr. *Playfair* is “the vegetable mould spread over the surface of the earth.”

Dr. *Hutton* is more particular: he says, (page 214) “a soil is nothing but the materials collected from the destruction of the solid
“land.”

“land,” but Mr. Kirwan shews, that soils are often of a different nature from the stratum they rest upon; and I add, from my own observation, that the soil covering our bleak high rocks (generally a spongy moss) was not formed by the destruction of the materials it rests upon, to wit, sound basalt.

That this soil is the great source of the detritus, or mud, carried down by rivers, we all three agree; but we totally differ from each other as to the materials from which this soil is formed.

Dr. Hutton from his definition of a soil, and the passages just quoted, shews, that he considers it as formed from the decomposition of the subjacent materials, regularly supplying the place of the soil, or superstratum, which is constantly moving away to the unfathomable regions of the ocean.

Mr. Playfair derives it from somewhat a different source, admitting in like manner, “that it is continually diminished;” yet states it *as a fact*, “that the soil notwithstanding remains the same in quantity,” and proceeds, “the soil therefore is augmented from other causes, just as much as it is diminished, and this augmentation evidently can proceed from nothing but the constant, and slow disintegration of the rocks; in the permanence therefore of a coat of vegetable mould, on the surface of the earth; we have a demonstrative proof of the continual destruction of the rocks.” (Illus. Page 106.)

I am afraid that in this passage, Mr. Playfair mistakes *assertion* for *demonstration*.

I consider that the superficial covering of the earth, called the soil, is formed from the decayed parts of vegetables, and animals; which will be found to afford an ample fund for the repair of the losses that all parties agree it sustains.

Though the decayed parts of animals are known to pass into earth, and of course, to augment the soil, I will limit myself to vegetables alone, conceiving their contribution, on this occasion, to be much more abundant.

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That vegetables derive their sustenance chiefly from air and water, while the portion they receive from the soil is a mere trifle, is a fact often demonstrated; and that vegetable matters turn upon decay into pure earth, every florist can testify, who forms his composts of decayed leaves.

The gardener too throws his weeds and refuse trash into an heap, that he may bring them back again in two or three years converted into fine mold.

Since, therefore it appears, that vegetables take little from the soil, and add much to it, I believe we need not look for any other source whence materials for the repair and renovation of our soil are to be sought.

Should this mode of forming, and supplying the superficial covering of our earth, be preferred to those of Dr. *Hutton* and Mr. *Playfair*, it may be unnecessary to proceed any farther in the discussion of the *Huttonian theory*; as its inventor has no excuse for obtruding a new world upon us, if it appears that the old world is not wearing out; nor will he easily find a place to put it in.

Rivers are, both with Dr. *Hutton* and Mr. *Playfair*, the great agents by which the inequalities of our surface are formed, and the materials of our world carried off.

Dr. *Hutton*, re-echoed by Mr. *Playfair* (page 351) is positive "of the great fact, that the rivers have in general hollowed out their vallies." and Dr. *Hutton* asserts, page 295, "we never see a river in a flood, but we must acknowledge the carrying away a part of our land."

I must admit, that on these occasions, rivers are loaded with adventitious matter; but very little of this comes from the original earth; it is the vegetable soil of posterior formation, (upon which we have already dwelt so much) easily abraded, and easily repaired, which discolours the rivers; this is obvious in all countries abounding with

turf moss, where the black colour of the waters discovers the source whence they were stained.

Mr. *Playfair* says, " Rivers have cut and formed, not the beds only, but the whole of the vallies through which they flow." (Page 353.) He told us before, " that all these channels have been cut by the waters themselves, and that it is by the repeated touches of the same instrument, that this curious assemblage of lines has been deeply engraved on the surface of the globe." (Page 103)

Yet *M. St. Fond*, when he found it necessary to account for the formation of a deep valley, *l'escarpment ou coule l'Ibie* admits the insufficiency of Mr. *Playfair's* instrument; and says, it was excavated not by that paltry brook (*chétif ruisseau*) but by some diluvian torrent. (min. des volcans 173.)

Dr. *Hutton* and Mr. *Playfair* seem to consider the inequalities on the surface of the earth, to be produced by the operation of rivers, as well as the excavation of vallies.

I will treat of these two questions separately, beginning with our mountainous inequalities; and, should I be so fortunate as to meet Mr. *Playfair's* desponding geologist in his Alpine regions, calculating how soon

—————" The great globe itself,
 " Yea, all which it inherit, shall dissolve;
 " And, like this unsubstantial pageant faded,
 " Leave not a rack behind."————

I would endeavour to dispel his fears by shewing him that the rivers, which he has been taught to think so active in the destruction of our globe, are very harmless, and that our inequalities have been produced by other agents, which by all appearance, have long ceased to act.

I would request him to observe, that in all mountainous tracts, there is a ridge higher than the rest, from which the waters run
 down

down on both sides, and generally at right angles; that this ridge, (very properly stiled by *Livy* the *divortia aquarum*) has been fixed upon as the boundary of *empires*, of *districts*, and of *properties*; that though out of the reach of rivers, this ridge often exhibits greater inequalities than the contiguous tracts; sometimes consisting of a succession of round, distinct mountains; at others, of a long *dorsum*, occasionally cut down in gaps, shewing the mountain strata at the same level on both sides.

I could shew him, that these gaps, (through which the roads crossing the mountains generally run) could never have been cut out by a river, unless we concede to Dr. *Hutton* his curious position (theory, page 296) “nor is there upon the continent, a spot at which “some river has not run;” his friend, Mr. *Playfair*, softens the expression a little, saying, *may have run* (353). If rivers have run once through such gaps, their course must have been up one side of the mountain, and down the other.

I would remind our geologist, that the long chains of mountains bounding the valley of the *Nile* on both sides, seem to have vallies and defiles exactly like our own; yet, in that country they have neither rain nor rivers. That hilly countries are alpine regions in miniature; their inequalities generally similar, though upon a smaller scale; yet such vallies are common without even a brook.

Rivers have been so much dwelt upon, by Dr. *Hutton* and Mr. *Playfair*, as the great agents and instruments employed in carrying away the materials of our world, that I must trespass a little farther on the reader's patience, for which I hope to be excused, the rather as it is a subject with which I ought to be well acquainted; my passion for angling having led me to explore the courses of most rivers I ever resided near; all of which nearly resemble each other, their differences arising merely from their different degrees of declivity.

Beginning at the mountain ridge, and descending, I boldly say that we find the valley begun before the rill appears, it being the *effect* not the *cause* of the valley, which, in such regions is often very great when the rill is insignificant, and (where the declivity is small) insufficient to cut a channel for itself, but forming a morass; it soon acquires quantity and velocity enough to form a channel, in which it runs peacefully at the bottom of the valley, increasing in size and rapidity; it now begins to commit some depredations, undermining occasionally the side of the valley it runs close to, especially if it happens to project; the materials tumble into the stream, are carried down, and deposited in different parts of its channel; if large, and heavy, they soon settle; if small, or soluble, they are carried farther.

The breach formed on the side of the valley, must necessarily be steep, as it is occasioned by the falling down of the materials, which have lost the base that supported them, and which would support themselves on a moderate declivity; it should also be rectilineal, unless where the valley and river correspond in similar curves.

Upon the whole, the portion carried away by the river, must bear the appearance of having been cut off by a plane, whose inclination does not deviate very far from the perpendicular.

It is not from our studies such questions should be discussed, we should refer to Dr. *Hutton's* code, *the book of nature*, and examine the facts upon the spot, before we deduce such general and theoretical conclusions, as he and his friend have done; I say *conclusion*, (rather than *assertion*) out of compliment to Dr. *Hutton*, who is perpetually calling his diffuse talk *demonstration*; it would be uncivil therefore, to call by any other name than *conclusion*, what he says, follows from it.

From the time that I was told that our rivers were carrying away the world, I have paid particular attention to them, whenever I had an opportunity; and I never met with a spot on their banks, where it could not be determined, on simple inspection, whether the sides of the valley wer original, or formed by the depredations of the river; in
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the latter case, the banks must be *steep, uniform*, and of a *given* declivity; while those with gentle inclination, mild swells, and varying surface, could never have been touched by Mr. *Playfair's* instrument.

Though he tells us, (page 111) "*the result of a more minute investigation, would be in perfect unison with the general impression of waste and decay;*" I should be glad to accompany his geologist, and to descend with him from his *Alpine tracts*, and trace the course of any river, from its source to the sea; I think I could shew him, that the places acted on by the river, since it first ran, were not many, and the quantity of materials carried off, comparatively nothing; that in several of these places, a bulwark had been formed at the base of the steep, by the stones and rubble which had fallen down, and that thus further depredations were prevented, of course that the *progress of decay* is not to be found in the courses of rivers.

Perhaps this geologist would not thank me for dispelling his gloomy visions,

" Cui sic extorta voluptas,
" Et demptus per vim mentis gratissimus error."

Should this be the case, and his imagination so habituated to depending speculations, that the prospect of ruin and desolation is become a necessary food to it, I would advise him, as there seems to be little hope of the world's making away with itself, to look for its destruction from external causes, and to calculate with *Swift's* wife islanders,

How soon the earth, by its daily approach to the sun, is likely to be absorbed by it?

How soon the sun itself will be incrusted by its own effluvia, so as to cease to give light and heat to the universe, and

How soon we may expect it will be consumed and annihilated, by the perpetual expenditure of its rays, without nutriment?

To

To return to our rivers; since it appears that the depredations they commit on their banks, are unimportant, let us try them in a vertical direction, and see, if in their channels and bottoms, they are invading and carrying off the world.

Mr. *Playfair* calls rivers, *lines deeply engraved on the surface of the earth*; I by no means admit this account of them, for where they run through plains, not alluvial, the river seldom is sunk more than a very few feet below the surface, and this is all the depth it has reached, since the beginning of the world: in alluvial plains they are perpetually changing their channels, cutting out new ones, and filling up the old; but this costs the world nothing, the river is acting upon its own deposits, carrying them off, and replacing them *ad libitum*, from the detritus of our soil, and this at a level above the original earth.

The reason why these lines are not deeper, is obvious; the bottom of the river, from its source to the sea, is covered with adventitious matter, stones, gravel, sand, mud, over these, without further invasion of the world, our river, like *Horace's*,

Labitur, et labetur in omne volubilis ævum.

That rivers in floods carry down with them vast quantities of mud, &c. cannot be denied, it remains to examine what becomes of it: the first deposit of the coarsest materials are made on the alluvial platforms, which abound in most rivers; Mr. *Playfair* calls them *haughs*; in the north of *Ireland* they are stiled *homes*; these (by his own admission) are found to be raised far above the level the river once ran at, a fact simple in itself, and easily accounted for; but so contrary to Mr. *Playfair's* system of perpetual excavation, that to get over the difficulty, he is obliged to *assume* that rivers, in their original form, were a succession of *lakes* and *cataracts*.

The principal consumption of the materials carried down by our rivers, is in the formation of alluvial land at their mouth, and the prolongation of our continents: still, however, we must admit that much

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is carried into the sea; the coarsest of this, which had been kept in suspension by the rapidity of the stream, is deposited as soon as the velocity is abated, in the greater expanse, and forms a bar at some distance without the mouth of the river; the remainder, consisting of the more subtle parts, continues for some little time to discolour the sea contiguous to the mouth of the river, and is acted upon by the tides.

Here I must venture to differ a little from Mr. *Kirwan*, as to the course of tides, for which I hope to be excused, as my experience upon that subject has probably been much greater than his; our conclusions, however, will be the same, though our premises are somewhat different.

Mr. *Kirwan* thinks the flood tide sets right in shore, and the ebb right out; that the flood is more impetuous than the ebb, and throws all floating things back on the shore; now the course of all tides with which I am acquainted, and, I believe, of tides in general, is in the direction (the trend as it is called) of the coast, the flood one way, the ebb the contrary.

Dr. *Hutton's* theory receives no support from this difference of opinion relative to the course of the tides. I live, in summer, on a coast between the mouths of two rivers, the *Bann* and the *Busch*, each subject to floods, the muddy water of which greatly discolours the adjacent sea: I have often amused myself, after heavy rains, watching from the high lands and precipices the course of these troubled waters, and have always observed them banded backwards and forwards along the shore, as the tide sets, and never reaching a mile from the coast; if, therefore, Dr. *Hutton* and his advocates persist in carrying on their operations of world-making, in the unfathomable regions of the ocean, they must look for other materials to work upon, than the *detritus* of our continents, not one particle of which will ever reach these regions.

A small quantity will not suffice, for, by Dr. *Hutton's* own account, he has two worlds always under hands in different stages of advancement,

ment, exclusive of the third that we inhabit, and which he thinks, is slipping through our fingers.

Dr. *Hutton* proves very clearly the necessity of having *two* new worlds going on at once, for otherwise we might remain a long time without any world, obviously a very great inconvenience; the passage in which Dr. *Hutton* establishes the necessity of three worlds, is very interesting, but quite too long for a quotation, I must therefore, refer the reader to his original work. Edin. Transactions, vol. 1st. pages 303 and 304.

Examination of Dr. Hutton's first Proposition a posteriori.

Hitherto we have proceeded in some sort by speculation, and conjecture; we will now try a mode of demonstration applied by Dr. *Hutton* to his second and third propositions, though not to his first. We will examine the Strata of the World, and try if they bear marks of having been formed at the bottom of the sea from the detritus of our continents, as Dr. *Hutton* asserts.

The coat of adventitious matter formed at the bottom of the sea, in the manner so minutely detailed, should be homogeneous, since the detritus from different parts of the world must be nearly the same; and even should they vary considerably, where first carried off the surface, they must be so mixed by the agitation of great rivers in their tedious journey from their sources, and still more in their long travel over the bottom of the sea, that by the time they reach the place of their destination, *its unfathomable regions*, they should be formed into

into a mass completely uniform, no distinction of strata in a vertical direction, nor change of the materials in an horizontal one.

But even should the detritus of the same place (from causes which I cannot develop) suffer a considerable change, so that the mass of deposit should have its upper and lower parts different; should also the detritus of places not far removed from each other vary materially, still, in both cases, the changes in the deposited mass should be gradual, and never *per saltum*. Now, should the strata to which we have access, differ in every respect from this description, are we not to conclude that they were not formed as Dr. *Hutton* supposes, and of course that his theory is false?

I shall, therefore, proceed, to give a short account of the materials and arrangement of the strata, in an extent of about thirty miles along our northern coast, where they are most happily displayed, and have not, as far as I can find, been examined by any naturalist. The circumstances attending these strata, seem to me to bear directly against every one of Dr. *Hutton's* positions, and I hope will plead my excuse (and I admit I require one) for having taken up a question already in much abler hands.

I begin at *Murlogh*, four miles east from *Ballycastle*. Here the precipice is composed of alternate strata of freestone and coal, inserted between mighty strata of columnar basalt; the contiguous northern face of *Fairhead*, consists of vast basalt pillars, 250 feet long each, its N. W. side alternate strata of freestone and coal.

The precipice is interrupted a little at *Ballycastle*, and immediately resumed on its west side; a stratum of white limestone forms the base, and is covered by successive strata of tabular basaltes; the limestone soon disappears, and is resumed again at *Kenbaan*, with alternate strata of basalt and limestone (sometimes mixed) over it; the covering of the limestone stratum now changes to an alternation of great strata of co-

columnar basalt, and a red ochrous substance, no doubt, decomposed basalt.*

At *Carrickarede*, this arrangement is changed into a solid unstratified mass of columnar basalt, 250 feet high, the alternate mass I have passed being about 400; above this the hill or mountain of *Knockfoghy* is composed of strata of columnar basalt alternately with another species of basalt (hitherto unnoticed, though common with us) of the same grain, but of quite different internal construction.

The coast now lowers for a few miles to the castle of *Dunseverick*, near which the bold promontory of *Bengore* projects into the ocean, displaying with great magnificence the various Strata of which it is composed.† To enumerate them all would be too tedious. I shall only observe, that the Stratum which (at the northern point of the promontory where they culminate) is the 8th from the water, and 250 feet above it, is composed of basalt pillars 44 feet long. At its eastern intersection with the plane of the sea, it forms the base of two beautiful islands, called *Beanyin Daana*, and at its western intersection, or immersion, two miles distant, it forms the *Giant's Causeway*.

For many miles westward, the face of the rock is composed of strata of table basalt, separated from each other by ochrous layers; this arrangement

* I have, in a memoir read before the Royal Society, *Edinburgh*, assigned my reasons for supposing the red strata, which make so conspicuous a figure in the faces of our precipices, to have been once pure basalt.

† These strata are sixteen in number, all ascending to the northward, in an angle greater than that made by the irregular surface of the promontory with the horizon; of these, ten only reach the face of the precipice at *Pliskin*, the remaining six pass or vanish in the air, before they arrive at it; but if the façade be pursued to *Portmoon*, a mile S. E. they will be found to appear successively on its summit, then dipping rapidly, and regularly, until they immerse beneath the water towards *Dunseverick*, the first ten having immersed in succession about *Portmoon*.

Traced westward, their descent is not so rapid, as the promontory, on this side, does not fall off so much to the southward; but the three lower of the six, and part of the fourth, appear often on the summit, wherever the height of the precipice is sufficient to have room for them, and each invariably in its own proper place.

rangement is interrupted at *Dunluce* for about a mile, by a precipice of stratified white limestone, near 150 feet high.

The range of perpendicular precipices is terminated at *Magilligan Rock*, by a beautiful façade 180 feet high, on the summit of a mountain, and composed of six and seven strata of rude columnar basalt, elevated near 2000 feet above the surface of the sea near it.

However entertaining this magnificent, and perpetually shifting scenery may be to the spectator, I fear the reader will think the detail tiresome; I shall therefore limit my observations on the stratification of these precipices, to such circumstances alone as seem to apply directly to Dr. *Hutton's* theory.

The strata in this whole range are horizontal, or nearly so, and in the same spot all steadily parallel to each other, except at *Fairhead* alone, where the strata of freestone and coal are inclined to the horizon, in a greater angle than the incumbent stratum of columnar basalt.

Every stratum, according to *Buffon's* rule, seems to preserve an uniform thickness through its whole extent, and to be of precisely the same nature in its whole thickness, with one exception; the variety of basalt, called for distinction, *irregular Prismatic*, is at its lower edge formed into small prisms, shooting in various directions, while its upper part is amorphous. †

By examining these accumulations of strata in a vertical direction, we find the impossibility of their having been formed as Dr. *Hutton* supposes, still more decided; for whether by their nature they approximate to each other, as in the several varieties of basalt; or whether they be totally different, as *sandstone, coal, limestone, basalt*; yet in all cases the transition from one stratum to another, is *per saltum*, and never *per*

(3 M 2) *gradus*.

† I have, in the Transactions of the *Royal Society, Edinburgh*, given, (amongst several varieties of basalt, hitherto unnoticed) a particular account of this species, which I call *irregular prismatic*; it seems to accompany the columnar basalt in most countries, their strata generally alternating.

gradus. The line of demarcation between contiguous strata, similar, or different, is as accurately defined, as if drawn by a pencil.*

It remains for Dr. *Hutton's* advocates to explain how the powers of nature were exerted, to separate for a time from the heterogeneous mass of far travelled detritus, one distinct species of matter to the exclusion of all others, so as to form a complete extensive stratum, for instance of limestone, then suddenly to change and collect another totally different, perhaps, sand-stone or argil; then as suddenly a third, or very likely to resume the first, as is the case in our alternations which so frequently occur.

The difficulties seem equally insurmountable, when we examine separate strata, and try whether, singly, they could have been formed according to Dr. *Hutton's* theory.

I begin with coal, both because its arrangement seems always to be in strata, and also, because it is particularly dwelt upon by Mr. *Playfair*, who says, in his 5th section, “ No fossil has its origin from the waste of “ former continents, marked by stronger and more distinct characters.”— “ There are entire beds of this fossil, which appear to consist wholly of “ wood, in which the fibrous structure is perfectly preserved.”—“ We “ cannot doubt that this fossil is every where the same, and derives its “ origin from the trees and plants which grew on the surface of the “ earth, before the formation of the present land.”

In

* To elucidate this fact, I give two small drawings, taken from parts of our grand façade, not far from *Pleikin*.

No. 1, is a portion of our 8th stratum (the same, which a mile westward forms the *Giant's Causeway*); with its transition into the ochrous stratum it rests upon (the 7th), and into the irregular prismatic (the 9th) incumbent upon it.

No. 2, exhibits a portion of the 10th stratum, composed of neat pillars, 54 feet long each, with their passage into the eleventh, formed of rude massive columns 14 feet long.

These sketches are the more to be relied upon, as they were taken without my knowledge, and without any view to the point I now refer them by my friend Capt. *O'Neil*, of the 56th regiment, who, by frequently assisting me with his pencil, has caught the spirit of a Naturalist, and is now as much struck by curious facts in Natural History, as by our magnificent scenery.

In section 138, Mr. *Playfair* tells us, that Mr. *Kirwan* makes a distinction between wood coal, “ in which the ligneous structure is so apparent as to leave no doubt of its vegetable origin ; and mineral coal, “ in which no such structure can be discovered.”—These two species of coal, Mr. *Playfair* says, “ the *Huttonian* theory considers as gradations “ of the same substance.”

And in section 145, accounting for the situation of a bed of coal, he says, “ It is part of a stratum of coal which has been deposited, “ like all others, at the bottom of the sea.”

Mr. *Playfair* should tell us, how the trees and vegetables of a former continent, have been able to preserve their fibrous and ligneous structure, after passing from one world to another through a process of decay, decomposition, and comminution ; also, in what form they travelled the long journey he obliges them to take, previous to their deposition at the bottom of the sea.

Similar difficulties attend the formation of calcareous strata, if we adopt the *Huttonian* theory ; for Mr. *Playfair* says, (section 2d.) “ These “ strata often contain shells, corals, and other exuviae of marine “ animals, in so great abundance that they appear to be composed of “ no other materials.”

And he tells us (section 402,) “ that all these, and even bodies of “ fish and amphibious animals, now converted into stone, are parts of “ animals not of the *present*, but of the *preceding* world ; yet neither he, nor Dr. *Hutton*, tells us, how these shells and bodies (often quite perfect) preserved themselves entire, in such a scene of decay and dissolution, as by their account must have intervened in the change from one world to another ; nor do they tell us by what means these exuviae were accumulated together, so as to form entire strata.

Were I to pursue this mode of discussion, and examine severally the different strata composing the superficial parts of our globe, I have little doubt but that the result would be, that not one of
them

them was formed in the manner so minutely detailed in Dr. *Hutton's* theory.

I must, therefore, decline concurring in the numerous compliments paid to him by his friend, Mr. *Playfair*, in a grave eulogium, occupying, with pure praise, no less than fourteen pages; and particularly I must decline admitting, "That the lapse of time must necessarily remove all objections to Dr. *Hutton's* theory." (Illus. page 138.)

And also, that the author of this theory, "will be remembered among the illustrious few, whose systems have been verified by the observations of succeeding ages, and supported by facts unknown to themselves." (Page 140.)

I shall now proceed to parts of Dr. *Hutton's* Theory, still more astonishing, where, to use Mr. *Playfair's* words, "the greatness of the objects which it sets before us, alarms the imagination;"—and again, "these are things with which, however certainly they may be proved, the mind cannot soon be familiarized."

Examination of Dr. Hutton's 2d Proposition,

That our Strata were consolidated at the Bottom of the Sea by Heat and Fusion.

In order to proceed with Dr. *Hutton's* theory, we must now give up the points we have hitherto been contesting, and admit the detritus of our continents to be deposited in the unfathomable regions of the ocean, where, he says, they were consolidated by heat and fusion.

The advocates for Dr. *Hutton's* theory, cannot reasonably expect that we should be more liberal in our concessions than he is himself; and as in refutation of some opinion with which I have nothing

" to

to do, he says, page 228——“ Thus it will appear, that to consolidate strata, formed at the bottom of the sea, in the manner now “ considered, operations are required unnatural to this place, consequently not to be supposed to support an hypothesis;” I cannot help thinking, that kindling fires at the bottom of the sea, and fusing all substances to be found there, *are performing operations unnatural to this place*, and consequently, not to be admitted merely to support Dr. Hutton’s hypothesis.

He is not the first who has fixed on the bottom of the sea, as a place where operations may be performed, which neither nature nor art can execute in our aerial regions.

M. St. Fond, as zealous a partizan of the *Volcanic Theory*, as either of our gentlemen is of the *Huttonian*, met with at Chamavelle, in the *Vivarois*, what he calls, *Un courant de lave compacte ; un Ruisseau de basalte en fusion* ; which had penetrated into limestone rocks, and mixed with calcareous substances in a most extraordinary manner, so that without seeing, without touching this basaltic lava, *L’on ne se persuaderait jamais qu’un fait pareil put exister dans la nature*.

A current of lava from *Etna* or *Vesuvius*, could in our days, he says, exhibit nothing similar. He is therefore reduced to a dilemma ; he must either give up the volcanic origin of basalt, or he must account for these extraordinary phenomena.

Giving up is out of the question ; no theorist was ever guilty of such a weakness ; he therefore, as well as Dr. Hutton and Mr. Playfair, must account for operations that could not have been performed in *air*, and like them, he has recourse to another element.

Flectere si nequeo superos, Acheronta movebo.

He pronounces positively, that the volcano was submarine, and poured forth its currents of lava along the bottom of the sea.

Upon

Upon this point, our lively Frenchman talks with much more pleasantry, than our grave northern philosophers; he says, “as to the
 “action of the aqueous fluid upon the glowing basalt, as to the ter-
 “rible combat, which must arise from the contact of water and fire,
 “when matters in fusion circulate at the bottom of marine gulphs, I
 “must confess, that this part of natural history has, as yet, made a
 “very small progress; that we are unprovided with accurate observa-
 “tions on the subject. Nature seems, on this occasion, disposed
 “to cover herself with an impenetrable veil, or rather science has ad-
 “vanced too little, and the code of facts is too new, to enable us
 “to solve demonstrably *ce beau probleme*.”*

The agents employed by these gentlemen, are totally different; *M. St. Fond* prevents his calcareous substances from calcining by the help of the aqueous fluid, while *Dr. Hutton* (as will appear) performs the very same operation, by incalculable pressure. (*Miner. des volcans*, chap. 13.)

Dr. Hutton (page 225) lays it down as a truth not to be questioned,
 “That the strata formed at the bottom of the sea, are to be con-
 “sidered, as having been consolidated, either by aqueous solution and
 “crystallization, *or* by the effect of heat and fusion.”

He then proceeds to prove, that they were *not* consolidated by *aqueous solution*, a question with which I have nothing to do; but where he makes use of an assertion positively contradicted by *facts* within my own knowledge, I think I am not at liberty to suppress them, though I do not take any part in the question.

Dr. Hutton says, (page 227) “it is inconceivable how these masses
 “should be absolutely consolidated, without a particle of fluid water
 “in their composition.”

No

* That the ingenuity of modern chemists has discovered *pressure* to be a powerful agent, I well know; as to “the wonderful success with which *Dr. Hutton* has applied it, to explain the most mysterious phenomena,” I cannot concur with *Mr. Playfair*.

No doubt, igneous fusion would at once satisfactorily account for the want of a particle of fluid water in these masses : let us try the fact ; I have frequently met with, in columnar basalt, cavities filled with fresh water ; I particularly refer to the stratum open at *Ballylagan*, two miles south from *Portrush* ; it is prismatic and columnar, and almost every stone when broken, contains cavities filled with fresh water.

Sometimes too, contiguous to the Giant's Causeway itself, I have found water in prismatic basalts, which I suspect had fallen from an upper stratum of pillars.

As these facts so positively contradict Dr. *Hutton's* assertion, which he puts so strongly ; and as they are obviously fatal to all Theories which suppose basalt to have been once in fusion, but have not (as far as I know) been observed by any other Naturalist, I am happy to have my solitary testimony confirmed by most respectable authority.

The Hon. Mrs. Stuart of Armagh, visited the Giant's Causeway last summer, and in one of the stones lying near it, which she had (among many others) directed to be broken, found in the inside of it, a cavity containing near two tea spoons full of water, also a nodule which she was so kind as to shew me ; it was a rounded rusty stone about the size of a marble, the interior was very fine chalcedony, coated with a stony substance of which the outside was smooth*.

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(3 N)

Dr.

* This is not the only fact Mrs. Stuart discovered, which had escaped the notice of so many Naturalists who have visited the Giant's Causeway, and even published accounts of it.

Mrs. Stuart shewed me in the Collection she had made, a number of small neat prisms, triangular, quadrangular, and trapezoidal, the sides of the very smallest less than half an inch ; of these minute prisms laid horizontally, our vertical *WHYNN DYKES* are formed. [See a preceding Memoir in this vol. upon *Whyn Dykes*.]

How a basalt, differing considerably in grain, and totally in form, from the contiguous Giant's Causeway basalt, could so long have escaped notice, is beyond my comprehension ; but neither Dr. Hamilton, nor any other writer, mentions these minute prisms, nor have I met with them before in any collection of basalt specimens, except where I deposited them myself.

Dr. *Hutton* having established, as he supposes, that his strata could not have been consolidated by aqueous solution, proceeds to prove *a priori*, that it must have been by igneous fusion.

I trust the reader will forgive me, for not following him through what Dr. *Hutton* himself calls (page 250) *a long chemico-minereal disquisition*), and especially when I inform him, that it contains near thirty quarto pages; nor is it necessary, as the Doctor proceeds to prove the same proposition *a posteriori*, and here I apprehend all parties will be better able to understand each other. He now states the appearances the strata of the world ought to exhibit upon each supposition, beginning with aqueous solution; in this case, he says, (page 258) “these masses should be found precisely in the same state, as when they were originally deposited from the water.”

“But if by igneous fusion, (page 259) then in cooling they must have formed rents or separations of their substance, by the unequal degrees of contraction which contiguous strata may have suffered.—There is not in nature any appearance more distinct than this of the perpendicular fissures and separations in strata.—There is no consolidated stratum that wants them, here is, therefore, a clear decision of the question.” And again, same page, (259) “in proportion as strata are deep, in their perpendicular section, the veins are wide, and placed at greater distances; in like manner, when strata are thin, the veins are many, but proportionably narrow.”

It is very extraordinary that Dr. *Hutton*, after positively and repeatedly resting his proof of igneous fusion upon these perpendicular fissures, occasioned by contraction in cooling, should not give us a single instance of the *fact*, nor refer us to any particular place where such fissures are to be found; we know that the contraction, after such a violent heat, must be very great; he himself admits, that, in deep strata, the veins are *wide*, and in thinner strata *frequent*, yet, in all the strata I have examined, on our northern coast, for thirty miles, and many of them from 50 to 60 feet thick, at *Portrush* too, where thin
strata

strata are accumulated on one another, and very convenient for examination, all these perpendicuar fissures have escaped me, though in his own words, *there is not in nature an appearance more distinct.*

Dr. *Hutton* seems to have forgotten, that he had said, (page 224,) “it is necessary to look into these consolidated masses themselves, in order to find principles from whence to judge of those operations, by which they had attained their hardness or consolidated state.”

And also, to have forgotten the rule he lays down, (page 273) “that, in order to have demonstration in a case of physical inquiry, we must have recourse to the *book of nature.*”

Now, I conceive this book should be referred to, like other books, by quoting chapter and page, and not by indefinite general assertion, that it contains such and such proofs.

I am aware, that Dr. *Hutton* considers our whyn dykes as filling up rents or fissures in the strata, occasioned by their contraction in cooling.

I have shewn in a preceding memoir, that it is by no means clear these mighty walls are of posterior formation to the strata they cut vertically, and also admitting the chasms to be antecedent, that they were not filled by glowing lava, as Dr. *Hutton* supposes; at present, we have only to enquire whether these immense fissures were formed by the contractions of the strata in cooling, I shall, therefore, state such facts alone as seem to me applicable to this point.

The distance between our dykes seems too great to suffice for the contraction of the strata; at the Giant's Causeway we have six in the space of a mile and half, at *Fairhead* five in nearly the same extent; the intervals between the dykes, in both places, are, by Dr. *Hutton's* own account, too great; he obviously insinuates we should find the fissures frequent, and positively asserts there is no consolidated stratum that wants them, yet the greater part of our precipices have not any whyn dykes, or fissures; at Cave-Hill, near Belfast, where the perpendicular fa-

gade extends a full mile, I have been able to discover but one dyke, and in the mighty face of Magilligan Rock not one.

Dr. Hutton admits, (page 259), that, in deep strata, the veins are wide, in thin strata narrow ; but in the faces of our precipices, where some strata are many times as thick as others, yet the fissures (filled, as he supposes, by our whyn dykes) are of uniform breadth in every stratum they cut.

He tells us also, that *contiguous strata suffer unequal degrees of contraction* ; no doubt, for, sitting in his study, he could never conceive that strata of freestone and of basalt would suffer the same contraction with thin veins of coal, knowing that different substances have different degrees of contractability ; but each whyn dyke, cutting these strata, at the colliery near *Fairhead*, preserves an uniform breadth from top to bottom ; the more accurate perpendicularity of the lofty precipices about the Giant's Causeway, exhibits this circumstance to great advantage in the dykes at *Ravinvalley* and *Port Spagna* on its east, and at the *Mile Stone* on its west side ; in these places the uniform breadth of the dyke is strongly contrasted with the different thicknesses of the strata.

When discussing Dr. Hutton's position, that our strata were formed by deposition at the bottom of the sea, I shewed how incompatible that opinion was with the state in which these strata are actually found, that is, accumulated upon each other in great numbers, of different materials, and each stratum compleatly distinct from the contiguous ones.

The difficulty seems equally unfurmountable, when he comes to consolidate these distinct strata by igneous fusion, according to the tenor of his second proposition ; for he must take his choice, either to kindle a fire at the bottom of the sea, fuse and consolidate each stratum separately, as soon as formed, then put his fire out, and wait until another stratum be ready for him, and so on ; or he must fuse the whole mass at once, without suffering the heterogeneous materials to
mix,

mix, or the parallel strata in the least to interfere with each other, a nicety of operation utterly unattainable in the laboratories of our upper regions.

I once thought, that when I found, at *Portrush* and its neighbouring islands, basalt strata abounding with marine shells, that I had got convincing proof basalt was not of igneous origin; I was not then acquainted with the powers of Dr. *Hutton's* submarine laboratory, nor did I know that he could there fuse substances, which in our fires are calcinable or combustible; but he expressly tells us, (page 282), “that if the theory now given be just, a rock of marble is no less
“a mark of subterranean fire and fusion, than that of the basaltes.”*

Mr. *Playfair* is more particular, and, as the reader probably never saw limestone exposed to violent heat without calcining, nor coal without burning, he may be glad to know how these refractory substances may be fused like metals, and melted like wax.

The great agent employed for this purpose is *pressure*, whose powers, by Mr. *Playfair's* account are so very extraordinary, that for fear of misrepresentation I shall carefully use his own words: he says, (section 132,) “The circumstance which gives Dr. *Hutton's* theory its
“peculiar character, and exalts it infinitely above all others, is the
“introduction of the principle of pressure, to modify the effects of heat
“when applied at the bottom of the sea, (sec 15) this important
“remark was first made by Dr. *Hutton*, and applied with wonderful
success,

* I wish Dr. *Hutton* had been so good as to tell us what marks of *fire and fusion* a rock of marble exhibits; the most striking circumstance that occurs on the inspection of a piece of marble is, that it generally abounds with marine shells, with their distinct forms accurately preserved; with us, in our limited, superficial experience, the invariable effect of fusion is the obliteration of all forms, interior or exterior, possessed by the mass before it was exposed to the fire: I presume the power of fusing without effacing forms, is one more of the many advantages which Dr. *Hutton's* subaqueous laboratory possesses over ours; still he leaves us in the dark as to the agent, whether it was his own pressure, or the marine acid, employed by *M. St. Fond*, on similar occasions; possibly, had he not been in a hurry, he would have introduced us to some new agent equally powerful.

“ success, to explain the most mysterious phænomena of the mineral
“ kingdom.”

Sect. 15. “ The tendency of an increased pressure on the bodies
“ to which heat is applied, is to restrain the volatility of those parts
“ which, otherwise, would make their escape, and to force them to
“ endure a more intense action of heat. At a certain depth under
“ the surface of the sea, the power even of a very intense heat might
“ therefore be unable to drive off the oily or bituminous parts from
“ the inflammable matter there deposited.” And again, (section 29)
“ The weight incumbent on the strata of coal, when they were ex-
“ posed to the intense heat of the mineral regions, may have been
“ sufficient to retain the oily and bituminous parts, as well as the
“ sulphureous.”

Coal, indeed, he seems to select, as a favourite substance for fusing
without burning; he says, (section 28,) “ This argument for the ig-
“ neous origin of the strata, is applicable to them all, but especially
“ to those of coal.”

It appears that calcareous substances are as easily melted as the
combustible, in Mr. *Playfair's* laboratory, (section 17,) “ Some bodies,
“ such as the calcareous, are able to resist the force of heat on the
“ surface of the earth, yet it is perfectly agreeable to analogy to
“ suppose, that under great pressure, the carbonic state being pre-
“ served, the purest limestone or marble may be softened or even fu-
“ sed:” and Section 25, “ calcareous earth, under great compression,
“ may have its fixed air retained in it, notwithstanding the action of
“ intense heat, and may by that means be reduced into fusion.”

Such is the mode by which Mr. *Playfair* endeavours to establish
his singular positions; and that his friend Dr. *Hutton*, has also suc-
“ ceeded, he seems perfectly satisfied: for he tells us, (section 25,)
“ In all this, I do not think he has departed from the strict rules of
“ philosophical investigation.”

Yet

Yet both Dr. *Hutton* and he shew a strong inclination to adjust matters with their readers by *postulate* and *admission*, rather than by the more crabbed process of demonstration.

Mr. *Playfair* says, (section 163,) “ a further postulatam is introduced in Dr. *Hutton*’s theory, namely, that compound bodies, such as “ carbonat of lime, when the compression prevents their separation, “ may admit of fusion.” And (section 17,) “ these effects of pressure “ to resist the decomposition of bodies and to augment their fusibility, once supposed, we shall find little difficulty in conceiving the “ consolidation of bodies by heat.”

Mr. *Playfair*, convinced of the accommodating dispositions of his readers, now takes for granted that his supposition is admitted, and shews, that he fully understands the importance of the concession, he says, (section 25,) “ The principle just mentioned, relieves us therefore “ from a difficulty that would have embarrassed, but could not have “ overturned this theory.”

Such is the sum of the *demonstrations*, or *postulates*, or *possibilities* (for it appears, much turns upon the word *may*) by which Mr. *Playfair* endeavours to establish the wonderful powers of his master’s subaqueous foundery, it is for the reader to determine, with what success he has laboured : I must now follow Dr. *Hutton* through other operations performed by the same agent, *subterranean heat*, not less wonderful, though totally different.

The third proposition concluding his theory, is stated by Dr. *Hutton* himself, page 263.

“ That the strata formed at the bottom of the sea, had been elevated as well as consolidated, by means of subterraneous heat.

This elevation of the strata of the world from the bottom of the ocean to the tops of our highest mountains, is one of the operations which Mr. *Playfair* has told us, “ alarms the imagination, and to which “ the mind cannot soon be familiarized.” Yet, as if our imaginations were not sufficiently alarmed already, and as if Dr. *Hutton* had not exerted

the

the powers of his machinery to their full extent, Mr. *Playfair*, of his own authority, (for I find nothing similar in his master's theory) must double this operation, and make the strata of the world take another dive to the unfathomable regions of the ocean, and then resume their elevated situations; he seems to think a world,

——demum votis respondet avari
Agricolæ bis quæ solem, bis frigora sentit.

or, in his own words, (section 109) “that has been twice heated in the fires, and twice tempered in the waters of the mineral regions.”

He takes care to be very explicit on this addition of his own, repeating, (section 121) “To this succeeded a depression of the same strata, and a second elevation, so that they have twice visited the superior regions, and twice the inferior.”

It is difficult to find patience for the sober discussion of such a suite of extravagancies, thus announced with solemn pomp; nor is it easy to preserve the gravity becoming a subject of natural history, when we find Mr. *Playfair* making the mighty strata of the earth perform such gambols.

He seems to have overlooked the situation of the world, as represented by Dr. *Hutton* (page 303 and 304) and to have forgotten, that at the very time he is making the venerable matron sustain such rude shocks, she is actually pregnant with two worlds, in different periods of gestation.* I think Mr. *Playfair* might be alarmed, least *alma mater tellus*, indignant at the unbecoming treatment she was receiving, should again, (as when roughly handled by Phaeton) expostulate, and, in words far more apposite to her present condition, exclaim,

Hosne mihi fructus, hunc fertilitatis honorem?

I must

* One of these worlds, Dr. *Hutton* says, (page 308) “which is formed and ready to be brought forth, must have been collected from the destruction of an earth which does not now appear.” While a younger embryo world is now forming from the detritus of our own world, as fast as it can reach the unfathomable regions of the ocean. Thus, by Dr. *Hutton's* account, we know of four worlds, one past, one present, and two to come. Mr. *Playfair* adds one more to the series, as he has discovered marks and tokens of a world antecedent to the predecessor of our present world.

I must now proceed with more seriousness to state the argument by which *Dr. Hutton* conceives he has proved that the strata of the world were elevated, from the bottom of the sea to the highest part of our land, by the force of subterraneous heat.

He says, (page 262) “ There is nothing so proper for the erection of land “ above the level of the ocean, as an expansive power of sufficient force applied under the materials at the bottom of the sea.”—Admitted.

Again, (page 263) “ The power of heat for the expansion of bodies is, “ so far as we know, unlimited ; but, by the expansion of bodies placed “ under the strata of the bottom of the sea, the elevation of these strata “ may be effected.”

Dr. Hutton says, “ The present question is, if this power of heat, which “ has certainly been exerted at the bottom of the sea for consolidating “ the strata, had been employed also for raising these strata.”

Dr. Hutton, taking for granted that his preceding proposition is fully proved, and considering himself as having found a proper power in the proper place, proceeds: “ Therefore, if there is no other way in which we may “ conceive this event to have been brought about—we shall have a right “ to conclude, that the strata had been elevated, as well as consolidated, “ by means of subterraneous heat.”

The reader must decide upon the cogency of this argument, which I have epitomized as fairly as I could.

Doctor *Hutton* admits a great defect in the proof of this part of his theory. He says, (page 285) “ But how that land is preserved in “ its elevated situation, is a subject on which we have not even the “ means to form a conjecture.”

I shall now proceed, in the Doctor's own words, (page 265) “ To “ consider how far the proposition, that strata were elevated by the “ power of heat above the level of the sea, may be confirmed from “ the examination of natural appearances.”

“ If,” says he, “ strata are erected with an expansive power acting “ below, we may expect to find every species of fracture, dislocation, and

“ contorſion in thoſe bodies, and every degree of departure from a horizontal towards a vertical poſition.”

“ The ſtrata of the globe are actually found in every poſſible poſition ; for, from horizontal, they are frequently found vertical ; from continuous, they are broken and ſeparated in every poſſible direction, and from a plane they are bent and doubled.”

Here again we are at iſſue, and agreed in our appeal to the ſame authority, *the book of nature*. Doctor *Hutton* tells us how, (according to his theory) the ſtrata of the world ought to be found ; and then, ſlightly varying his expreſſion, aſſerts that ſuch are the poſitions in which they are actually found.

To every particle of this ſtatement, the face of nature in my country gives the moſt direct and poſitive contradiction. I refer to the account I have already given of the arrangement of our ſtrata, in an extent of thirty miles, from *Murlogh* to *Magilligan Rock*, to which I will now add the iſland of *Rathlin*, the ſteadineſs of whoſe horizontal ſtrata, is viſible, even from the main : they are alſo better diſplayed on its northern face, than any where I have mentioned, the precipice being uninterrupted for three miles and an half, generally much above 400 feet high, with the peculiar advantage of being perpendicular quite to the water, which is moſtly of great depth.*

I need

* The conſtrast between the ſteady paralleliſm of our ſtrata, and the inequalities of our ſurface, perpetually, and almoſt capriciouſly varying, affords a ſubject of curious ſpeculation. That theſe ſuperficial inequalities do not in the ſlighteſt degree ariſe from cauſes acting from beneath, is obvious to inſpection ; nor am I acquainted with any natural powers that could even aſſiſt in performing the operations that have been executed upon our ſurface ; abrupting precipices, and carrying off materials to an inconceivable amount, without in the leaſt diſturbſing what was left behind.

If my time would allow, I could ſtate a number of moſt curious *facts* on this ſubject. Vaſt Atlantic torrents ſweeping our earth with irreſiſtible rapidity, have been invented for the purpoſe of accounting for the very irregular appearance our ſurface exhibits ; but it would be eaſy to ſhew from the *facts*, that thoſe were not the agents employed ; our rivers I have already proved to be utterly inadequate to produce the effect.

I need not proceed further to shew, that the strata of my country have not sustained the operations which Dr. *Hutton* asserts have been performed upon the *strata of the globe*; but it may be objected that my arguments are local, and though they may restrict, should not overturn a general conclusion.

The objection is fair, but I believe will scarcely be offered by Dr. *Hutton's* advocates; for, from the nature of his theory, no spot in the world can be exempted from his revolutionizing operations, which, as he himself tells us, (page 253) “have been not only general, as found “in all the regions of the globe, but universal.”

I by no means insinuate, that the strata over the world are always as steady as in our basaltic country; schistus strata, in particular, are often very much inclined; but I argue only from what I have seen, and from *facts* for which I make myself responsible.

Dr. *Hutton* seems to consider *wobynn* dykes as a strong confirmation of his theory. To me they seem utterly irreconcilable to it. We know that they cut through all strata they meet with, to depths we have in no instance been able to reach, and are generally perpendicular (such at least is the description of those with which I am acquainted). Dr. *Hutton* too (page 278) traced one *twenty or thirty miles* in length.

He must determine whether these enormous *septa*, were formed before or after his supposed elevation of the strata from the bottom of the sea, to the summits of our mountains; if before, how came these mighty walls to preserve their perpendicular position and long rectilinear course, in the midst of such a tremendous explosion, as by his own account, *fractured, dislocated and contorted* the other strata, changing their position from horizontal to vertical, and breaking them in every possible direction; from planes bending and doubling them?

If he makes these *wobynn dykes* posterior to the explosion, and formed by fluid lava, injected upwards through the fissures formed by the disruption of the strata; how can we conceive such steady perpendicularity in chasms formed in the midst of a scene of such confusion,

and disorder, as he himself describes? and how comes it that his lava (which must have been in an high state of fluidity, to admit its passage through such narrow crevices) stops in every single instance when it reaches the surface, without spreading along it when its confinement was at an end?

The next topic I shall mention, seems to me of itself decisive against Dr. Hutton's theory; I mean, *columnar basalt*, which he never once notices. This is the more extraordinary, as he seems to have seized as his private property, all the varieties of basalt, calling it *unerupted lava*, fused in his own submarine laboratory. He complains of the *Volcanists* for invading this property, and gives marks and tokens by which his unerupted lavas (basalts) may be at once distinguished from their erupted lavas, the obvious product of volcanos.

Still, however, *columnar basalt*, the most curious and important part of his property (as having of late excited so much attention) escapes him; no doubt it would have embarrassed him to account for the steady vertical position which these pillars retain in most places, after the subversion and jumble of his strata, which he so particularly describes. There are, I know, in other countries, instances where these columns deviate considerably from perpendicularity; with us (where such colonades are without number) the deviations are few and trifling; and even on these occasions, though the pillars are deranged, the stratum is undisturbed; for I cannot call the depressions that occur in a few places, a *disturbance*, since the permanent and depressed strata, continue to preserve a steady parallelism to each other.

Mr. Playfair is more particular on the subject of basalt than Dr. Hutton, and, as usual, more clear; but each of them, separately, gives such an account of this fossil, its department in the operations of nature, and its arrangement when exposed to our view, as excites my astonishment. It has been my misfortune already to differ often from them, both as to facts, and opinions; but when they come to treat of basalt, my contradictions must be much more decided; for
though

though I am acquainted with the personal respectability of these gentlemen, and the high literary characters which each of them bears, I cannot suffer important facts in Natural History to be totally misrepresented, for the purpose of supporting the wildest opinions that ever entered the brains of speculatists.

I hope Mr. *Playfair* will excuse me, when he finds he is not the only person whose statement of *facts* I have been under the necessity of contradicting; and that I have, on different occasions, been obliged to treat every naturalist who has published an account of our basaltic coast, exactly in the same way, and to shew where they misrepresented our facts for the purpose of supporting their own systems.

I by no means insinuate, that an overweening zeal in support of opinions, which have nothing to do with common life, affects the moral character. Lawyers are used to take great liberties, when warmly defending their clients.

“Tunc immensa cavi spirant mendacia folles;”

without committing their own veracity; and I think it not unlikely that *system-makers* may think themselves entitled to the same latitude, which *Ovid* allows to another description of gentlemen.

“Jupiter ex alto perjuriam ridet amantum,

“Et jubet Eolios irrita ferre notos.”

In the common course of Natural History, *facts* should regulate *opinions*; the reverse happens in modern times, as it appears *opinions* have a great influence on the statement of *facts*.

I have already discussed so many wild opinions, broached by these gentlemen, that I might be excused for not encountering another, which does not seem necessarily connected with the demonstration of their theory; but when I find the *subterraneous fusion and flowing of basalt*, adopted by a naturalist of Sir *James Hall's* respectability, I will treat the opinion with a deference due to every thing countenanced by him.

With

With Dr. *Hutton*, basalt or *whynn* is a lava flowing in the bowels of the earth, driven upwards by some powerful agent ; forced into the fissures and crevices of the strata, and sometimes impelled with such violence between parallel strata as to separate them from each other, and to lodge between them.

That this substance, out of the reach of our ambient air, and acted upon by incalculable pressure, possesses many properties totally different from those of common erupted lava.†

When Dr. *Hutton* and Mr. *Playfair* pronounce so positively, that basalt is subterranean lava, they do not attempt to enter into any proof that it ever was in fusion ; they content themselves with denying to it such properties, as are obviously incompatible with the origin they give it.

Stratification is one of these ; for it is clear from their own account of this substance, that it could not be arranged in Strata ; Dr. *Hutton*, therefore, makes a grand distinction between stratified and *unstratified* bodies ; of the latter, all he enumerates are *granite*, *porphyry* and *basalt*, or *whynn*.

As I am not acquainted with granitic countries, I can throw no light upon this part of the subject ; I shall only observe, that the stratification of granite, is maintained by *Pallas*, *De Luc* and *Saussure* ; even Mr. *Playfair* himself seems to give it up.

Porphyry, Mr. *Playfair* tells us, (section 76) is a variety of *whynn* ; the *whynn-stone* of the old world. He forgets, however, to tell us how

† That basalt is often found as described by Mr. *Playfair*, cannot be denied ; it alternates with calcareous strata, in many places, though in our extensive basalt country it mixes with it (and that slightly) but in one spot, *Kenbaan*. Its arrangement over the world seems to be in accumulations of extensive, parallel strata, covering the surface of the earth ; so, at least, our whole basaltic country is covered. Of such arrangement, Mr. *Playfair* takes not the least notice ; it is, indeed, fatal to his system, at first glance ; for, exclusive of the impossibility of disposing his lava in regular strata, yet, admitting it was done, his *unerupted* lava, now is become erupted, and being spread on our surface, exposed to the air, and relieved from *pressure*, should possess all the properties of common volcanic lava, derived, by his account, from the same source ; but he labours to shew, that important differences do and *ought* to exist between them.

how it escaped the general disintegration of all the rocks of that world; and how, in its present unwieldy masses, it travelled from the *old world* to the *new*, without undergoing the process of comminution, an operation by the foregoing theory, indispensably necessary to enable it to perform the journey.

As to the stratification of *whynn-stone*, or *basalt*, Mr. *Playfair* is positive. He says (section 76) “to conceive aright the origin of that class of unstratified rocks, distinguished by the name of whynn-stone;”—and again, same section, “these unstratified rocks;”—also, (section 62) “Whynn, though not stratified.”

Mr. *Playfair* (section 29) considers it as a good defect in *Buffon's* Theory, “That it makes no distinction between stratified and unstratified bodies;”—“this system, therefore, has but a very distant resemblance to the *Huttonian* Theory;”—and again (section 125) “*Buffon* has no means of explaining the unstratified rocks.”

From this last passage it is obvious, that Mr. *Playfair* considers the want of stratification in the rocks he mentions, as indispensably necessary to Dr. *Hutton's* Theory.

It is now full time to come to *facts*; I must, therefore state, that nature seems to me to have arranged *basalt*, that is, *whynstone*, in more regular strata than any other substance whatsoever; to confirm this, I must request the reader to turn back to a passage in this memoir, in which I gave a minute account of the strata of our basaltic country, in a course of thirty miles, nineteen parts of which out of twenty, are accumulations of basalt strata, arranged with consummate regularity.

Wherever we find the same material, nature has disposed it in the same manner; thus, if we proceed southward from *Magilligan* rock, by the basaltic mountains of *Bien Braddock* and *Carntogher*, to the point where the basalt terminates in the abrupt faces of *Monynceny*, hanging over the valley of the *Mayola*; we find the base of all these mountains a mighty stratum of white limestone, upon which successive basalt strata are heaped upon one another quite up to their summits: the regular stratification of this mass is occasionally disclosed, whenever abrupt precipices occur,

occur, and more frequently by the strata themselves baffeting on the sides and summits of the mountains.

In the whole of our extensive basalt country, I have met with but one spot in which this substance is not regularly stratified, namely *Car-rickarede*, where for about 200 or 300 yards, the basalt precipice seems one solid mass.

There is a circumstance attending basalt, which much increases my astonishment at hearing it classed among unstratified substances, that is, it seems to be the only species of rock whose arrangement in strata discovers itself to the eye at all distances. The contrast between our *basalt* and *schistus* mountains is every where most striking, and the difference chiefly arises from the stratified arrangement of the basalt.

I think it possible a skilful naturalist, who had given his attention to this point, would, in sailing along a newly discovered coast, be able to pronounce on the materials of the mountains as he passed them, merely by their distant outlines; my experience has been too limited to permit me to proceed farther with this topic, I only suggest it to naturalists, who may have opportunities to make such observations.

The reader will probably be surpris'd to find Mr. *Playfair* perfectly acquainted with this natural arrangement of basalt, and ready to make his use of it, in his controversy with the *volcanists*, who claim his *whynstone* as their *eruptive lava*; and that stratification is one of the characteristic marks, by which he distinguishes his *unerupted* lava from their erupted.

He says, (section 236) "There are other marks that distinguish the lavas " which we suppose to have flowed in the mineral regions, from those " which actually flowed upon the surface—the physical geography of whyn-stone countries, unlike in many respects to that of volcanic countries; the " shape of whyn-stone hills; their large flat terraces rising above one another; their perpendicular faces."

I see now that the natural arrangement of basalt, in Mr. *Playfair's* country and mine, is precisely the same; for what are *large, flat terraces, rising*

one above another, but accumulations of extensive basalt strata? and, I dare say, his *perpendicular faces*, like those with us, enable him to observe the uniform thickness which each stratum preserves in its whole extent,* and the consummate regularity with which the mass is arranged.

Mr. *Playfair* says, that Mr. *Kirwan* did not view nature with his own eyes; I am curious to know, with whose eyes he himself discovered basalt to be an unstratified substance; had I not met with the passage I have quoted, I should have been tempted to doubt the evidence of my own. That the reader may not remain in a doubt between us, I shall appeal to the testimony of my friends, and request, before he decides, he will examine the sketches Captain *O'Neil* has given, of portions of the strata of *Pleekin* and *Port Spagna*, and still more the view of the magnificent façade half a mile farther eastward, and the view of the precipice at *Cave-hill* above *Belfast*, taken by my friend Captain *Chapman*; and I can assure him these were all taken before either I, or my friends, suspected any naturalist would be so hardy as to support his system by denying the stratification of basalt.

Mr. *Playfair* is pleased to dwell minutely on the fossils of *Port-rush* Promontory, and their arrangement, which last he has never seen: he says the shells found there in basaltic rocks, have been of late much insisted on as a proof of the aqueous formation of these rocks; and again, “these specimens with shells were supposed

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“ he

* From this rule the uppermost stratum must always be excepted, for, while the plane bounding its lower side is invariably rectilineal, and parallel to the mass of the strata below it, its upper side partakes of all the inequalities of the surface, and is perpetually undulating or sloping away to a point, where the stratum vanishes; the inequalities instantly transferred to the stratum next to it, now become the uppermost, follow the former stratum in the contrary direction, and another will, probably, soon appear over it, to which the irregularities will be transferred.

The confused manner in which basalt is disposed on the surface, might mislead cursory observers, but Mr. *Playfair*, by his own account, has perpendicular faces where the arrangement of the strata must necessarily be disclosed.

“ (he believes) to contain an irrefragable proof of the Neptunian
“ origin of the basaltic promontory where they were found.”

Perhaps so, but not by me who discovered them: I communicated the fact as new in Natural History, and sent specimens to the curious wherever I had an opportunity, but I did not apply this fact to the support of any theory; I never insinuated that I thought the *Neptunists* had penetrated farther into the secret of Nature than other Theorists, and I furnished Dr. *Hope* of Edinburgh with such facts as occurred to me that seemed favourable to the *Plutonic System*, which I understood he had supported from his *Chair*.

I now congratulate myself that I did not engage in these wars, since I have found that the combatants use most dangerous weapons, and come into the field as well accoutred as one of *Homer's* champions.

———πας δ' ἄρα χαλκῷ
Σμερδαλίῳ κεκαλυφθ'

My authority is from Mr. *Playfair* himself, who says, (page 297)
“ Thus the weapons which directly pierce the armour of the Vol-
“ canist, and inflict a mortal wound, are easily turned aside by the
“ superior temper of the *Plutonic mail*.”

Nature makes her genera and their varieties, on many occasions, approximate so close to (or rather pass into) each other, that it is not easy to make distinctions with certainty, nor is it fair to deduce from a fossil whose class is disputed, an argument for or against any theory; I shall therefore abstain from making such use of this *silicious basalt*, (as my friend Professor *Pictet* called it); but since such eminent Naturalists as he and Mr. *Kirwan* differ upon this point, from gentlemen of such respectability as Sir *James Hall* and Professor *Playfair*, I think it incumbent upon me who discovered this fossil, to assign my reasons for having originally called it basalt.

I know

I know that Sir *James Hall* has acquired most deservedly, great credit for his skilful management of his Laboratory, in fusing basalt without impairing its stony appearance; to differ from him, therefore upon a basaltic subject, will, I fear, be deemed presumptuous; but it must be observed, that Sir James did not analyse this fossil; he (as Mr. Playfair tells us) pronounced upon inspection alone; nor has he possessed the same advantage that I enjoy, of viewing it in its natural state and arrangement.

From these last, strong arguments may be drawn to prove it to be *basalt* and not *schistus*, as Sir *James* thinks; the strata of this stone and of the contiguous basalt are exactly similar, and of equal thickness (about 14 inches each;) they are sometimes disposed in alternate strata, sometimes in accumulations of each species separately.

The surfaces of the strata of filicious, and of unquestioned basalt, equally exhibit rude *pavés*, and when quarried into, equally produce massive prisms; those in the filicious basalt break into smaller prisms, mostly irregular pentagons of every size down to great minuteness.

Mr. *Playfair* says, "The specimens he saw had nothing of a "sparry or crystallized structure." If by this he means they were not of *prismatic form*, I refer him to the cabinet of his friend Dr. *Hope*, where he will find many of the specimens of this filicious basalt, actual prisms, as they might all have been but for the difficulty of conveying large specimens so far.

Prismatic construction is utterly incompatible with the fissile nature of schistus, but it seems to be a property essential to basalt; I never found this fossil in its original stratum (and it is always stratified) that it was not disposed in prisms, and although the great prisms of the columnar basalt do not break into smaller, yet there are other varieties which have a subordinate principle of construction, the large prisms breaking into smaller, as in the basalt dykes, and also

in our filicious basalt, and in a lesser degree in the coarse basalt contiguous to it.

I have, it is true, found one or two detached pieces lamellated, (they had been long exposed,) but nothing similar ever occurred in the original strata, nor have I met with a single particle of schistus in the whole extensive basaltic area: Schistus too is generally refractory, while the filicious basalt is easily fused and vitrified, and in its conchoidal fracture it more resembles basalt than schistus.

The strongest argument seems to be deduced from its grain, which may be traced in different specimens (in any of the collections I have given to Dr. Hope or our own Museum) passing from the likeness of *jasper* or *flint*, by insensible shades, until its grain approaches to, and then becomes coarser and more granular, than the Giant's Causeway basalt.

I hope Sir *James Hall* will be induced to analyse this stone; if he then shall pronounce it not to be basalt, I venture to predict it will be among the *filicious*, and not the *schistose* tribe he will class it.

Whatever may be finally decided as to its class, its arrangement with that of the contiguous basalt at Portrush and its islands, are fatal to a favourite position strenuously insisted on by the Plutonists, to wit, "That their fused unerupted basalt has been forced " up from the subterranean regions, and violently injected between " strata of other materials, by which their alternations with these " strata are formed."

Thus Mr. *Whitehead* accounts for the alternate strata of limestone and toadstone (*basalt*) of which part of *Derbyshire* is formed, to the greatest depths human industry can penetrate; he even flatters himself so far as to think, he had discovered the funnel by which the fluid lava had passed up from the centre of the earth.

In

In like manner Mr. *Playfair* supposes his lava was injected between the strata of this Portrush stone with shells; and at once considering the fact as established, he proceeds to avail himself of it, and to account for some similar appearance in the island of *Cerigo*, which he says, "The Italian Naturalist (*Spalanzani*) supposes "to be of volcanic origin."

These he admits would have been embarrassing, "without the "commentary afforded by the Portrush specimens." From these he concludes, "that in both cases the shells are involved in parts of "the rock, which have been in some degree assimilated to the "basalts, by the heat they have endured."—" *Spalanzani* would probably have used exactly the same terms which he employs in "speaking of *Cerigo*, if he had been required to describe the petrified shells at *Portrush*." (Page 289.)

Whether *Spalanzani* would have been equally ready to have accommodated the *Portrush* facts to his theory (a very different one from Dr. *Hutton's*) I will not take upon me to determine; but unfortunately they are most perversely contrary to what Mr. *Playfair* asserts (pages 287, 288): "Upon the whole it is evident, that the "rock containing the shells has acquired a high degree of induction by the vicinity of the great ignited mass of whyn stone."

No doubt so it ought, according to Mr. *Playfair's* Theory; and he must have thought it no great stretch to assert, that things actually were, as he thought *they ought to be*.

Unhappily the very contrary is the fact; for, instead of this stratified stone being affected "by the vicinity of the great ignited "mass of whyn stone," the alteration at the contact is made upon the whyn stone alone, which grows somewhat finer as it approaches the line of demarcation; and what makes this more provoking is, that it is the single instance in which I have found any stratum affected by the contiguity of another.

The

The next liberty Mr. *Playfair* takes with our *facts* is more guarded, and expressed with hypothetic caution. "If (says he) a torrent of melted matter were poured in among the strata, by a force which at the same time broke up and disordered these strata."

No doubt such a torrent must have broke up and disordered our strata, and therefore Mr. *Playfair* insinuates (for I cannot now say he asserts) that our strata have been so *broke up and disordered*. Here too the facts are directly contrary; for in the place where the stones with shells and impressions are found, there is no disorder nor breaking up. The strata of *filicious basalt*, and of *admitted basalt or whyn stone*, are all steadily parallel, and of uniform inclination, to wit, a slight dip to the eastward, from which, upon the authority of Mr. *Playfair* himself, we may fairly conclude that no such torrent as he supposes, was ever injected among our strata.

Mr. *Playfair* brings us to the peninsula of Portrush, with a considerable degree of triumph. He could not have chosen a more unfortunate spot for his theory, as it abounds with facts irreconcilable to the operations he supposes to have taken place.

On the main, where the strata are deep and accumulated upon each other to stupendous heights, Nature (as I have shewn early in this Memoir) changes her materials, and her mode of arranging them, every two or three miles; but on the east side of Portrush peninsula, where the strata are thin, she changes her stile almost every hundred yards, passing from accumulations of alternate strata to an accumulation of *filicious basalt*, then to a similar one of what Mr. *Playfair* admits to be undoubted basalt in regular strata; such sudden changes in materials and arrangement, by no means resemble the effect of a mighty cause acting deep in the bowels of the earth, and forcing up torrents of liquid lava with irresistible violence.

I have already dwelt sufficiently on the very different opinion maintained by Mr. *Playfair* and me, as to the stratification of basalt.

I must

I must, however, state the *fact* that on the side of Portrush which Mr. *Playfair* mentions, pure basalt is more abundant than the silicious; and whether mixed with it or not, is always disposed in regular strata of uniform thickness, from 12 to 20 inches; and the west side of the same peninsula at 400 yards distance, is one mighty stratum of rude pillars from seventy to eighty feet long.

I fear I may have detained the reader too long upon this little interesting peninsula, where I have spent the pleasantest part of my life. I should be happy to have an opportunity of shewing to Mr. *Playfair* its curious facts; and how Nature, who every where around us executes her works *en grand*, here assumes a diminutive stile; and to make him amends for the arguments I have drawn from this spot to combat his theory with, I would shew him that it bears equally against other opinions; and that if he has mistaken our facts, other writers have overlooked them.

Mr. *Whitehead* and Mr. *Mills* have each of them published accounts of our coast; each of them was at Portrush, yet nothing there seems to have excited their attention; even Dr. *Hamilton* who spent many summers on the peninsula, and dates his letters from it, let all our curious facts escape him.